VOLTAGE REGULATOR FOR ALTERNATOR AND METHOD OF CONTROLLING POWER GENERATION OF ALTERNATOR

CROSS REFERENCE TO RELATED APPLICATION

This application is based on and incorporates herein by reference Japanese Patent Applications No. 2000-313726 filed October 13, 2000 and No. 2000-185446 filed June 19, 2001.

BACKGROUND OF THE INVENTION

The present invention relates to a voltage regulator for a vehicle alternator and a method of controlling the power generation of an alternator for a vehicle.

It is proposed in U.S. Patent No. 6,191,562 (JP-A-2000-60191) to protect a power Zener diode of an alternator by improving a drive circuit of a power transistor so that magnetic energy is dispersed by making conductive the power transistor when electric load cut-off condition is generated. Thus, when a battery is cut off, supply of field current from the battery can be stopped.

However, it has been found that since high voltage is applied to the field winding of the alternator to increase a field current in the alternator of the structure to supply directly a field current from the DC output terminal of a full-wave rectifier of the alternator, the output voltage of the alternator is set in the positive feedback condition. Thereby, magnetic energy increases.

Moreover, when the battery is placed from the condition

of being not completely cut off, for example, to a condition where the harness is not perfectly fixed electrically at the output terminal of alternator, or a connection failure occurs anywhere in a power feeding cable, comparatively small surges of voltage are repeatedly applied to the power Zener diode irregularly within a short period. In this case, a large amount of heat accumulates because of the repetitive generation of heat, even though in comparatively small amounts. Therefore thermal damage becomes larger in this case than in the case where one comparatively large surge of voltage, such as that generated when a rated load is cut off or disconnected is applied.

Fig. 22 shows changes in temperature T when a reverse current I is repeatedly generated in the Zener diode. AC voltage is usually generated in the armature winding. Therefore this voltage becomes high, when a failure occurs. It thereby exceeds the reverse breakdown voltage Vz of the Zener diode, and the diode reverse breakdown allows a reverse current to flow. This is a rectangular wave current and the frequency thereof depends on the number of rotations of the rotor.

In this case, an instantaneous value of energy to be consumed in the Zener diode is given in the form of $Vz \cdot Iz$ (Iz is a reverse current flowing into one element). This energy is converted to heat and is classified into the energy accumulated in the thermal capacitance in proportion to the volume of element and the energy dispersed to the external side, with thermal resistance to be transferred through a member forming an element (such as electrode, soldering material and sealing material).

Therefore, temperature instantaneously rises in comparison with the initial value T0 with the thermal energy accumulated in the element. Finally, when normal conditions are recovered and high voltage disappears, the reverse current is cut off and the temperature of the element is gradually lowered. In this case, if the high voltage condition is maintained for a long period of time, the temperature of the element continuously rises, resulting in the possibility of thermal breakdown of the element.

It is also proposed to increase the thermal capacitance by expanding the area of the diode element. However, mounting becomes difficult if such an increase of thermal capacitance is realized, because of the spatial limitation on the small size alternator. Moreover, it is also proposed that effective thermal dispersion can be realized by lessening thermal conductivity to the external circuits. However, it is likely that in a usual power generating operation temperature rises excessively due to radiation of heat from the external side.

Moreover, when normal diodes are used for the full-wave rectifier of the alternator, high voltage is not absorbed and appears on the power supply line. Accordingly, an electrical system protection device of a vehicle may be damaged.

SUMMARY OF THE INVENTION

The present invention therefore has an object to alleviate electrical and thermal damage to a rectifier of an alternator and a vehicle electrical system due to the high voltage that is repeatedly generated by the alternator.